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Value and provision of ecosystem services from prairie wetlands: A choice experiment approach

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ABSTRACT

Wetlands are critical to the provision of valued ecosystem services. The intensification of agriculture has increased the conversion and degradation of wetlands on privately owned lands. The purpose of this paper is to inform the development of effective wetland conservation initiatives in western Canada. A choice experiment is used to estimate the value of changes in wetland ecosystem services to residents of the province of Saskatchewan. With a focus on water quality, wildlife habitat and riparian zone width, among a myriad of wetland ecosystem services, we estimate partial values for wetland conservation. Random parameter logit models, with and without interaction terms, are used to estimate willingness to pay values for wetland ecosystem services. Compensating surplus welfare measures are also estimated for management scenarios representing changes in the quality and quantity of wetland ecosystem services. The results suggest that society ascribes positive value to the wetland ecosystem services with water quality attributed the greatest value. Finally, we find that while Saskatchewan residents feel that landowners and society have a responsibility to preserve wetlands on privately owned land, society should be responsible for 50% or more of the costs of preservation initiatives, thereby supporting publicly funded wetland policy.

1. Introduction

The primary objective of land management on the Northern Great Plains of North America is the production of agricultural commodities including annual crops, and intensive and extensive livestock production. Widespread modification and degradation of prairie ecosystems, and thereby constrained capacity to provide the full range of important ecosystem services, is an important consequence of increasingly intensive production of agricultural commodities. The Millennium Ecosystem Assessment (2003) defined ecosystem services (ES) as the direct and indirect benefits people obtain from ecosystems. A definition for ecological goods and services proposed by de Groot (1992) framed ecosystem functions as "the capacity of natural process to provide goods and services that satisfy human needs, directly or indirectly". Prairie wetlands represent an important contributor to a wide range of agri-ecosystem functions and their presence and health are critical for the provision of many valued ES. However, agriculture is largely focused on managing ecosystems for the specific production of agricultural commodities, thereby limiting the capacity of these ecosystems to provide the full range of ES (Swift et al., 2004; Power, 2010). Wetlands located on private agricultural land have often been viewed as an impediment to annual crop production and as a result have been steadily degraded and lost due to drainage and encroachment (Bartzen et al., 2010; Zedler, 2003).

Within Canada, policy that influences wetland management is comprised of a mixture of federal and provincial initiatives. Canada has signalled a commitment to wetland conservation through international agreements such as the Ramsar Convention on Wetlands and the Rio Declaration on Environment and Development (Farnese and Belcher, 2006). Canada's Federal Policy on Wetland Conservation (Environment Canada, 1996) commits all federal departments to a policy of no net loss of wetland function, but on federal and crown land and waters only. Wetland conservation on private land is only addressed in the federal policy through public awareness of the importance of wetlands and voluntary individual actions. Wetlands in Canada generally fall under provincial authority. Provincial wetland policies are specific to the provincial needs and many have recently been undergoing change. For example, the province of Alberta released its most recent wetland policy in 2013 with an implementation timeline from September 2014 through June 2016 (Government of Alberta, 2013). In June of 2014 the province of Manitoba introduced a new

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'Surface Water Management Strategy', to be implemented by 2020, which includes changes to wetland drainage rules (Government of Manitoba, 2014). The province of Saskatchewan conducted a public drainage consultation process in 2013–2014 to direct changes to the provincial wetland drainage and management policy in the near future (Saskatchewan Water Security Agency, 2014).

The recent changes to strengthen and expand wetland conservation legislation across the Canadian Prairie Provinces highlights the specific policy challenge of ensuring that agri-ecosystems provide a socially desirable balance of agricultural commodities and other ES. One of the barriers to the development of policy to address ES provision is appropriate representation of the preferences and values that farmers and society hold for those ES. A wide range of ES values have been characterized, including those linked to material contributions to human well-being and a spectrum of important non-material values and ES linked to, for example, cultural benefits (Millennium Ecosystem Assessment, 2003). Brown et al. (2007) stated that the benefits that humans gain from a well-functioning ecosystem can be understood from many perspectives including physiological, psychological and economic. The present research addresses wetland ES values from an economic perspective. Valuation of ES to help inform development and policy decisions has been an active area of research for a number of years (Farber and Costanza, 1987; Costanza et al., 1997; Daily, 1997; de Groot et al., 2002; Fisher et al., 2008; Barbier et al., 2011). These estimated values, even though they are inexact and incomplete (Howarth and Farber, 2002), can inform the design of more effective wetland conservation program incentives by helping to understand relative gains and losses (Brown et al., 2007).

Who should be responsible for managing resources important for ES provision, or who should bear the cost of provision, are important considerations in the development of policy measures to support environmentally beneficial agriculture management. Examples of valued ES provided by prairie wetlands include groundwater recharge, flood and erosion control, carbon sequestration, biodiversity, and air and water purification (Brander et al., 2006). Whether it is the clean air they breathe, the clean water they drink, or the observation of wildlife they enjoy, society is in favour of protecting and enhancing wetland related ES. For example, through the North American Waterfowl Management Plan (NAWMP), government and non-government organizations in the United States and Canada have invested significant public resources to secure and enhance wetland and associated upland wildlife habitat in Canada (North American Waterfowl Management Plan, 2014). However, in the absence of agreements or policy measures that involve some form of ecosystem investment or payment, the costs of providing these ES are primarily borne by the private landowner, usually the farmer, while the benefits are shared across society with the farmer receiving only a small proportion of the total benefits. The distribution of costs between farmers and society is an important consideration in the choice of appropriate policy tools. The purpose of this paper is to estimate a component of the perceived social value of wetland ES provided within the agricultural landscape of the province of Saskatchewan. We also focus on determining the factors that influence this part of the perceived value of wetland ES and the acceptable level of public/private responsibility for ES provision.

2. Background

Within agricultural landscapes farmers adopt management practices that either directly or indirectly increase, conserve, or decrease the level of ES provision. However, land use practices in Canada are often selected for the purpose of provisional services (e.g., food production), usually at the expense of environmental conservation and protection (Belcher et al., 2001). van Vuuren and Roy (1993) found that while the social net benefits from wetland preservation exceed those from conversion to agriculture, private net benefits from conversion exceed those from preservation. This is true in the prairie provinces of Canada, where the private net costs of wetland preservation have been shown to be a strong incentive to farmers to convert wetlands resulting in decreased provision of wetland ES in agricultural landscapes (Porter and van Kooten, 1993; Van Kooten and Schmitz 1992). To understand land management incentives in this region Cortus et al. (2011) assessed the economic feasibility of draining wetlands on farms in eastern Saskatchewan. These authors found that a rational farm operator would drain wetland areas, at an average cost of $500/ha, rather than purchase new lands, at an average cost of $640/ha, to expand their cultivated land base. The economic incentives to drain and convert wetlands have generally increased as technological changes have decreased the mechanical costs of draining wetlands while larger agricultural equipment has increased the private costs of field obstructions, including wetlands (De Laporte, 2014). Cortus et al. (2011) reported that the reduction or elimination of in-field nuisance cost imposed by wetlands located in annual crop fields contributed approximately 35% of the private benefits achieved from draining wetlands. Wetland drainage on existing lands is a profitable management practice since, from the perspective of the farmer, wetlands provide insufficient or no significant direct financial benefit (De Laporte, 2014; Cortus et al., 2011). Therefore, on privately owned agricultural land, policy measures that encourage the adoption of land management that decreases private net benefits to meet an objective of increasing social net benefits requires positive, often monetary, incentives (Pannell, 2008; Brown et al., 2007).

From society's perspective, wetlands perform a range of functions that arise from the interaction of the structural components (soil, flora, and fauna) and the physical, chemical, and biological processes (Seyam et al., 2001). Many wetland functions are interdependent since one process has an influence on more than one function. This implies that the continuity of a single function is not separable from other functions; it depends on the maintenance of the integrity of the entire system (de Groot, 1992; Seyam et al., 2001). A significant body of literature cautions that separating ES for the purpose of monetary valuation obscures the complexity of ecosystems and that ES are worth more than a defined price (Kosoy and Corbera, 2010; Vatn, 2010). As such, a barrier to economic valuation is how to characterize ecological systems as components that are both consistent with ecological science and meaningful to society (Carson and Mitchell, 1993). This literature reveals that an important concern with valuation approaches that simplify and decompose ecosystems is that only partial values for ES will be estimated and they must be interpreted recognizing this caveat.

An approach proposed by Boyd and Krupnick (2009) characterized ecosystems in a way that is consistent with standard production theory by considering ecosystem production functions that transform biophysical inputs into ecological endpoints. Biophysical inputs are converted through natural processes into different environmental features or conditions, while ecological endpoints are a subset of biophysical outputs that have direct value as inputs to firms or households (Boyd and Krupnick, 2009). In this characterization, ecological endpoints require little or no translation to make their relevance to utility clear as the endpoints represent things people experience and make choices about (Kontogianni et al., 2010). For example, the dissolved oxygen level in water does not have a tangible meaning to non-experts since it is not directly experienced and is not typically the subject of